

What is claimed is:

5 1. A data storage system including a cache comprising a variable number of levels, each level having a cache controller and a cache memory wherein means are provided for address mapping to be recorded and applied between each level of the cache.

10 2. A data storage system as claimed in claim 1, wherein the means for address mapping are provided for a level between that level and the level above in the cache.

15 3. A data storage system as claimed in claim 1, wherein the cache includes means for creating a new level in the cache above an existing level and means are also provided for tying an address mapping to the existing level.

20 4. A data storage system as claimed in claim 1, wherein the address mapping between the levels of the cache corresponds to a point in time virtual copy operation which has been committed to the cache in electronic time.

25 5. A data storage system as claimed in claim 4, wherein a new level is created in the cache when a point in time virtual copy operation is committed to the cache.

30 6. A data storage system as claimed in claim 4, wherein a plurality of point in time virtual copy operations are tied to a single level provided the point in time virtual

copy operations do not conflict with any intervening writes to the cache.

5 7. A data storage system as claimed in claim 1, wherein the cache includes means for deleting a level of the cache including means for destaging data from the level to underlying storage devices.

10 8. A data storage system as claimed in claim 1, wherein lower levels of the cache are destaged before upper levels and after a level is destaged, the address mapping recorded for a destaged level is applied to underlying storage devices.

15 9. A data storage system as claimed in claim 1, wherein the data storage system also includes a processor and memory, and underlying data storage devices in the form of an array of storage devices having a plurality of data blocks organized on the storage devices in segments distributed across the storage devices, wherein when a data block in a segment stored on the storage devices in a first location is updated, the updated data block is assigned to a different segment, written to a new storage location and designated as a current data block, and the data block in the first location is designated as an old data block, and having a main directory, stored in memory, containing the locations on the storage devices of the current data blocks.

10. A data storage system as claimed in claim 9, wherein
the data storage system is in the form of a log
structured array and the point in time virtual copy
operation is a snapshot copy operation.

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11. A data storage system as claimed in claim 4, wherein
the point in time virtual copy operation is a flash copy
operation.

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A cache comprising high-speed memory, the cache
having a variable number of levels, each level having a
cache controller and a cache memory, wherein means are
provided for address mapping to be recorded and applied
between each level.

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13. A cache as claimed in claim 12, wherein the means
for address mapping are provided for a level between that
level and the level above in the cache.

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14. A cache as claimed in claim 12, wherein the cache
includes means for creating a new level in the cache
above an existing level and means are also provided for
tying an address mapping to the existing level.

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15. A cache as claimed in claim 12, wherein the address
mapping corresponds to a point in time virtual copy
operation which has been committed to the cache in
electronic time.

16. A cache as claimed in claim 15, wherein a new level
is created when a point in time virtual copy operation is
committed to the cache.

5 17. A cache as claimed in claim 15, wherein a plurality
of point in time virtual copy operations are tied to a
single level provided the point in time virtual copy
operations do not conflict with any intervening writes.

10 18. A cache as claimed in claim 12, wherein the cache
includes means for deleting a level of the cache
including means for destaging data from the level to an
underlying storage system.

15 19. A cache as claimed in claim 12, wherein lower levels
of the cache are destaged before upper levels and after a
level is destaged, the address mapping recorded for that
level is applied to an underlying storage system.

20 20. A cache as claimed in claim 15, wherein the point in
time virtual copy operation is a snapshot copy operation.

25 21. A cache as claimed in claim 15, wherein the point in
time virtual copy operation is a flash copy operation.

30 22. A method of data storage comprising reading and
writing data to a cache having a variable number of
levels, wherein the method includes recording and
applying address mapping between each level of the cache.

23. A method of data storage as claimed in claim 22,
wherein the address mapping is provided for a level
between that level and the level above in the cache.

5 24. A method of data storage as claimed in claim 22,
wherein the method includes creating a new level in the
cache above an existing level and tying an address
mapping to the existing level.

10 25. A method of data storage as claimed in claim 22,
wherein the address mapping between the levels of the
cache corresponds to a point in time virtual copy
operation which has been committed to the cache in
electronic time.

15 26. A method of data storage as claimed in claim 25,
wherein the method includes creating a new level in the
cache when a point in time virtual copy operation is
committed to the cache.

20 27. A method of data storage as claimed in claim 22,
including the steps of: writing data to a first level of
the cache until a point in time virtual copy operation is
committed to the cache; recording the mapping defined by
25 the point in time virtual copy operation; tying the
record to the first level; creating a second level of the
cache; writing subsequent writes to the second level of
the cache.

28. A method of data storage as claimed in claim 26,
wherein a plurality of point in time virtual copy
operations are tied to a single level provided the point
in time virtual copy operations do not conflict with any
intervening writes to the cache.

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29. A method of data storage as claimed in claim 25,
wherein the point in time virtual copy operation is a
snapshot copy operation.

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30. A method of data storage as claimed in claim 25,
wherein the point in time virtual copy operation is a
flash copy operation.

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31. A method of data storage as claimed in claim 22,
including the steps of: receiving a read request in the
cache; searching a first level of the cache for the read;
applying the address mapping for the next level to the
read request; searching the next level of the cache;
continuing the search through subsequent levels of the
cache; and terminating the search when the read is found.

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32. A method of data storage as claimed in claim 31,
including the step of remapping a read request by
applying all the address mappings of the levels of the
cache to the read request and applying the remapped read
request to an underlying storage system.

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33. A method of data storage as claimed in claim 22,
wherein the method includes deleting a level of the cache

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including destaging data from the level to underlying storage devices.

34. A method of data storage as claimed in claim 22,
5 including the steps of: destaging data from the lowest level of the cache to an underlying storage system; applying the address mapping for the lowest level to the underlying storage system; deleting the lowest level of the cache.

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35. A method of data storage as claimed in claim 22, wherein the data storage is arranged as a log structured array storage subsystem including a write-back cache.

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36. A computer program product stored on a computer readable storage medium, comprising computer readable program code means for performing the steps of reading and writing data to a cache having a variable number of levels, recording and applying an address mapping between 20 each level of the cache.